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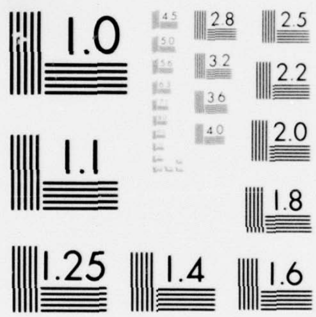

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VISUAL SEARCH TIMES FOR NAVY TACTICAL INFORMATION DISPLAYS

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VISUAL SEARCH TIMES FOR NAVY TACTICAL INFORMATION DISPLAYS

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An experiment was conducted to determine the time and accuracy with which an operator could find target items in each of six preformatted information displays. The displays corresponded to two versions (long and short) of three CRT formats proposed for the Naval Tactical Data System (NTDS). The number of items on the displays ranged from 6 to 40. — next page

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Operators were tasked to retain either a two- or four-consonant letter set in memory during the search task. Following a fixed time to perform the search, single letter probes were presented to determine that the memory set had been maintained.

Reaction times to the search task increased as the number of items in the display increased, but search times were not influenced by the concurrent memory task. Reaction times to the memory probe revealed faster response to the two-letter set than to the four-letter set. There were no significant effects attributable to practice, relative display screen location, or interactions between the memory task and the display search.

Total amount of information on the display was, therefore, the only relevant factor of those examined. Future effort should be concentrated on different search requirements, scan patterns, display area segregation, and practice or operator skill level.

FOREWORD

This research was conducted in support of Advanced Development Subproject Z0107-PN.08, Information Processing in Operational Decision Making, under the sponsorship of the Chief of Naval Operations (OP-01), and in support of the Fleet Combat Direction Systems Support Activity (FCDSSA), Operation Requirements Section (Code 27). This is the first NAVPERSRANDCEN study using the Navy Tactical Data System (NTDS) operator console as a testbed in examining man-machine interface in decision-making processes.

Appreciation is extended to CDR H. P. Krienke, LCDR W. L. Schwabe, LT A. L. Maples, and LT J. L. Dick of FCDSSA, Pacific who provided the NTDS materials; Mr. Jon Everson who was responsible for some of the data analysis and provided many helpful suggestions; and the Commanding Officer, U.S. Naval Station, San Diego, who provided invaluable assistance by allowing use of Naval Station personnel as "console operators."

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

The Naval Tactical Data System (NTDS) maintains and updates a large amount of information that must be retrieved and presented to a variety of console operators with varying retrieval tasks. An additional cathode ray tube (CRT) is being provided system operators in order to increase the flexibility and speed with which information can be presented. Thus, it is necessary to determine the optimum format display and the amount of information that can be readily scanned by the operator.

Objective

The objective of this effort was to examine a variety of NTDS information display formats and sizes to determine search and data entry speed while the operator is occupied with a secondary task. This situation simulates the multiple demands of an NTDS console.

Approach

A visual search task with a reaction time measure was designed on a PDP-12 minicomputer. Inexperienced operators memorized a set of consonants (2 or 4 letters), then were exposed to a search display and a target. They were required to locate the target in the display and respond as rapidly as possible. There were six search displays, alternately presented. These consisted of two versions (long and short) of three formats. One of these formats currently is being used with NTDS, and the other two were developed by the Fleet Combat Direction Systems Support Activities as a part of the display standardization for NTDS ongoing in both the Pacific and Atlantic Fleets. The operator was required to locate a target item within the display and enter the 3-digit value assigned to that item on a numeric keyboard. Finally, they were queried to determine if they had maintained the consonant set in memory. Measures of the reaction time and accuracy to each display size and format were obtained and used to determine the influence of display size, display format, relative display location, concurrent memory load, and practice on operator performance.

Findings

1. The main finding was that display size (number of items in the display) significantly influenced reaction time to locate the target item.

2. Specific formats did not differ in ease of target item location except as a function of their size.

3. The number of letters (two or four) held in memory on the secondary task did not influence display search performance.

4. Operators responded significantly faster to the memory task probe on the two-letter set than on the four-letter set.

5. Practice and relative display location did not significantly influence performance.

Conclusions

Total amount of information in the display is the primary predictor of search time performance in this task. Whether other display formats can effectively reduce the display size for the operator, and thereby reduce search time, remains to be seen.

Recommendations

The following follow-up research should be conducted:

1. Compare nonsegregated formats with a system of boundary segregation by conceptual classification.

2. Examine responses requiring multiple-item integration, trading-off a single large display, and multiple small displays with operator call-up.

3. Examine scan patterns in a controlled manner using segregated and nonsegregated formats as in (1) above.

4. Compare results using both experienced and inexperienced operator personnel.

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INTRODUCTION

Problem

The Naval Tactical Data System (NTDS) permits shipboard personnel quick access to large amounts of tactical information via consoles located on board. Since the variety and amount of information available to a console operator is potentially overwhelming, a continuing RDT&E effort must be conducted to present the information in a form that is easily grasped by operators and commanders who must take action or make decisions thereon. To this end, the Fleet Combat Direction Systems Support Activity (FCDSSA) in both Atlantic and Pacific Fleets is engaged in a program to replace a portion of the console display with an additional cathode ray tube (CRT) alphanumeric display. This auxiliary device (the IP-1304/UYA-4 Digital Display Indicator) permits greater and more flexible information display than heretofore.

Purpose

This experiment was conducted to define the format and amount of information that could be scanned and grasped by a console operator. From this knowledge, FCDSSA programmers can determine the display program requirements that will accompany the installation of the auxiliary digital display indicator on board Navy ships.

Background

Applied visual search studies are generally directed toward solving problems of the information display itself. This is in contrast with visual search studies concerned with the cognitive processes of the individual (Monk, 1976), which have been oriented towards questions of individual information processing capacity. Both approaches use similar measures, the most common being time taken to locate a target and some indication of accuracy. The time measure may be reaction time or processing rate or both, and the accuracy measure is the number of hits or misses. In a typical paradigm, the subject is given a target item drawn from a target set, followed by a display set containing several items. His task is to locate the target item in the display and respond, either verbally or manually. His action may involve either a simple detection response (Yes/No) or a more complex act such as entering the item on a keyboard.

The most pervasive finding of previous studies has been that the search time increases and accuracy decreases as the number of items in the display increases (Egeth, Atkinson, Gilmore, & Marcus, 1973; Teichner, & Mocharnuk, 1974; Atkinson, Holmgren, & Juola, 1969). Much of the research has been devoted to studies of slope contrasts of the function that relates reaction time to the number of displayed items. Search functions that do not show an increase with number of displayed items do exist, however. The most common explanation for such flattened functions is that the displayed items are scanned in a parallel fashion. This has been attributed to individual information processing capacity (Gardner, 1973), as well as to particular information display formats (Egeth, Jonides, & Wall, 1972).

Scope

Our research has the applied perspective in that it is concerned primarily with the form of display that might reduce the search rate. Such forms might effectively aid the operator in applying a more efficient search process.

Certain limitations on the research are necessarily imposed by the technical platform that is involved. Since the NTDS uses a fixed set of acronyms on consoles that are already in operation, the only part of the present system that may be influenced by research results is the software used to ouptut data to the display screen. This study was, therefore, directed toward two aspects of display that are controlled by software: the total number of items displayed and the format. Within the latter, specific constraints were imposed by the results of earlier studies (e.g., Notes 1, 2, and 3) and standardization requirements imposed by FCDSSA. In this initial experiment, therefore, we are concerned with search times and accuracy imposed by sets of preformatted displays.

The NTDS operator is involved in a variety of tasks in addition to searching for items on a display. He might, for example, be required to retain in memory some information from another source while searching for the target item on a display. In studies of human cognitive processes, multiple-demand tasks are useful for determining how individuals share limited resources. For example, some components of attention or short-term memory are limited and therefore must be allocated. These considerations led to the development of another task, interpolated with the visual search, that would simulate the multiple demands on the NTDS operator. In this task, the operator is required to maintain a short set of consonants in memory during performance on the search. The basic paradigm is attributed to Sternberg (1969) and has been widely used in examining memory retrieval strategies and capabilities. Typically, after memorization of the item set, the individual is given a probe item and must respond by indicating whether or not the probe was a member of the memory set.

Wattenbarger and Pachella (1972) took Sternberg's (1969) character classification task and imbedded within it a choice reaction time task to determine whether a small memory load would have an effect on the choice reaction time. Since there was none, the authors concluded that, under a small memory load ($<$ 6 items), no interference exists. Wattenbarger and Pachella's findings were confirmed by Kelly (1976) and extended to include recall as well as classification of the memory set. The influence of similar short-term memory load on visual search, involving latencies longer than one second, has not been determined.

This experiment therefore was designed primarily to investigate search time and accuracy in a set of specific preformatted displays. An additional character classification task was imposed to simulate the operator's environmental demands and to expose the possible influence of small memory loads on the search performance.

METHOD

Participants

Twenty-four Navy enlisted men from the transient barracks at the Naval Station, San Diego participated in this study. Their ages ranged from 18 to 36, and all were tested for 20/20 vision (corrected). None of the participants had had any previous experience with NTDS console operation.

Apparatus

The entire task was programmed on a DEC PDP-12 computer using two oscilloscope display screens. The two screens were arranged vertically to correspond with the plan position indicator (PPI) and auxiliary display of the NTDS console (Figure 1). A Tektronix 4006/1 graphics terminal served as the PPI or operator console and was used in this simulation to present the consonant set for memorization, the target item to be located, and the letter probe for memory test. A DEC VTO-5 alphanumeric terminal served as the auxiliary display and rested on top of the operator console. This terminal was used to present the display from which the target item was to be located.

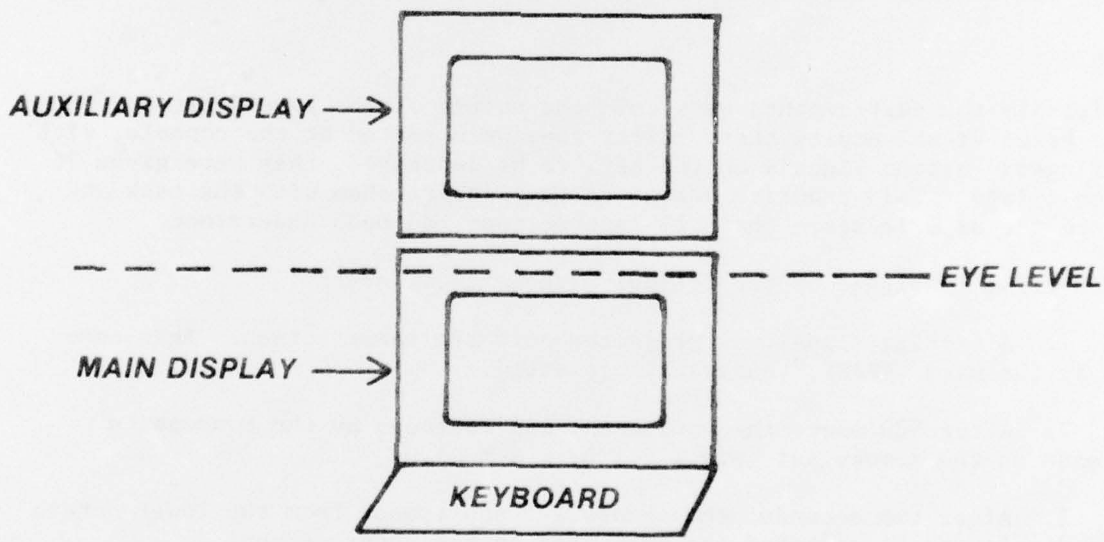

Figure 1. Display terminals.

Operators sat in a dimly-lighted, sound-dampened room with their eye level approximately midway between the two screens. They had not been dark adapted. They responded to the queries on the keyboard of the operator console, which was located at desk level, immediately in front of their chair.

Information Displays

Six display formats were chosen from a set of 19 provided by FCDSSA, San Diego. These represented two sizes (small and large) of three format styles. The first format style is that currently in use on NTDS consoles. The other two were those developed by FCDSSA, Dam Neck and by FCDSSA, San Diego, respectively. These six display formats are illustrated in Figure 2. As shown, the displays include one or two lines of recommended course of action (e.g., AIR FRND STRK/SUPP ASW in Figure 2.a), plus a number of display items consisting of NTDS acronyms of two to five characters (either letters or letter-number combinations).[1] These acronyms were taken from sets provided by FCDSSA, San Diego. The number of items provided ranged from 6 (Figure 2.a) to 40 (Figure 2.f).

Each of the display items was paired with a random 3-digit number. For example, in Figure 2.a, the acronym TN was paired with 129. Upon locating the target item, which consisted of one of the display items, chosen at random, the operator was to enter the corresponding 3-digit number into the keyboard.

Procedure

Initially the participants were told the nature of the experiment and then given a brief visual acuity test. After they were seated at the console, with their fingers resting lightly on the keys to be depressed, they were given 26 practice trials. This practice served to familiarize them with the task and to assure the experimenters that all instructions had been understood.

Each trial consisted of the following sequence of events:

1. A warning signal was projected onto the lower screen. This consisted of the word "READY," centrally presented.

2. After 500 msec, the word READY was replaced by the consonants which made up the memory set (e.g., F Z or K B M C).

3. After two seconds, the memory set was erased from the lower screen and the display to be searched was presented on the upper screen.

4. Immediately following the presentation of the display (event 3), a target item, which was to be located on the display, was presented on the lower screen.

5. The operator located the target item in the display and entered the 3-digit number corresponding to the target on the keyboard. Reaction time was recorded to entry of the last digit.

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[1]For purposes of this study, the action lines also were considered as display items.

```
AIR FRND STRK/SUPP ASW
TN   129                              CUS   585
PIF  172                              SPD   217
                                      ALT   463
```

2.a. Current NTDS format (small size)--6 Display Items.

```
ENGAGE

AIR FRND INT/FGTR CAP
TN    392
PIF   977


MK76  685    MK54  829    LB11A  317    MK84  563    FUEL  498
MK44  244    FFAR  314    SU44A  822    MK58  164
MK46  201    HVAR  885    NAS    942
MK57  246    MK52  578    NPS    486
```

2.b. Current NTDS format (large size)-- 19 Display Items.

```
                                                      GMT   392
AIR UNK
TN    977                  CUS   685
PIF   829                  SPD   317
BRG   563                  ALT   498
RNG   244                  SIZ   314
```

2.c. FCDSSAPAC format (small size)--10 Display Items.

```
ENGAGE

AIR FRND INT/FGTR CAP                             GMT   392
TN    977                  CUS    685             ACQ   829
PIF   317                  SPD    563             LST   498
BRG   244                  ALT    314             STQ   822  RR  164
RNG   201    THRT  885     SIZ    942             LTQ   246  CU  578
MK76  406    MK54  676     LB11A  724  MK84  839  FUEL  214
MK44  542    FFAR  895     SU44A  287  MK58  755
MK46  702    HVAR  625     NAS    276
MK57  301    MK52  468     NPS    488
```

2.d. FCDSSAPAC format (large size)--33 Items.

Figure 2. Display formats for search task as shown on auxiliary display.

SURF	FRND LINE CV							GMT	392		
TN	977	RRR	685	CUS	829	M1	317	ACQ	563		
PIF	498	LAT	244	SPD	314	M2	822	LST	164		
BRG	201	LONG	885	ALT	942	M3	246	STQ	578	RR	406
RNG	676	THRT	724	SIZ	839	M4	214	LTQ	542	CU	895

2.e. FCDSSALANT format (small size)--24 Display Items.

ENGAGE

AIR	FRND STRK/SUPP ASW							GMT	392		
TN	977	RRR	685	CUS	829	M1	317	ACQ	563		
PIF	498	LAT	244	SPD	314	M2	822	LST	164		
BRG	201	LONG	885	ALT	942	M3	246	STQ	578	RR	406
RNG	676	THRT	724	SIZ	839	M4	214	LTQ	542	CU	895
MK76	287	MK54	755	LB11A	702	MK84	625	FUEL	276		
MK44	301	FFAR	460	SU44A	488	MK58	103				
MK46	539	HVAR	460	NAS	571						
MK57	548	MK52	578	NPS	341						

2.f. FCDSSALANT format (large size)--40 Display Items.

Figure 2. Continued.

6. If the operator could not locate the target in the display within 8 seconds from the time event 4 was completed, the screens were erased and the operator was notified that he had taken too much time. Such a trial was recorded as a lapse trial, and the program returned to event 1.

7. A single consonant memory probe was presented on the lower screen. This required a Yes-No response on one of two predetermined keys on the keyboard. The operator responded Yes, by depressing the proper key with his right-index finger, if the probe was a member of the set presented in event 2; and No, by depressing the proper key with his left-index finger, if it was not.

The maximum duration of an entire trial, including all of the events listed above, was 20 seconds. The timing was controlled so that a fixed interval of 15 seconds elapsed between presentation of the memory set (event 2) and presentation of the memory probe (event 7).

Each subject received a total of 120 trials. Within every set of six trials, the operator randomly observed all six display formats. Each of the six formats were thus presented 20 times, and total time to complete the task was about 1 hour.

Data obtained from 6 of the 24 participants were eliminated from the statistical analysis either because those individuals performed the concurrent memory task at chance level or because they could not locate the target item in the display a sufficient number of times to provide an adequate sample. It was felt that analyses should be performed only on data obtained from the remaining 18 participants, who had demonstrated their capability of performing at the level required under actual conditions.

Only those trials on which the operator was correct on both display search and memory test were used in the analysis of display search rates. This criterion was adopted to ensure that equal performance demand prevailed during each rate measurement; however, separate analyses of errors were also conducted.

Display Search

Response times to the display search showed a linear increase as the number of items in the display increased. A two-way analysis of variance (ANOVA) was performed on the search times. The first ANOVA factor was display size with six levels; and the second, the number of letters (either two or four) being held in memory during the search. The effect of display size was significant (F (5, 85) = 51.35, $p < .01$).[2] As the number of items in the display increased, so did the search time (Figure 3). There was no difference that could be attributed to the size of the memory set, nor was there an interaction between search time and memory set size. The function in Figure 3 is represented by the equation $Y = 34.58 (X) + 4203$.

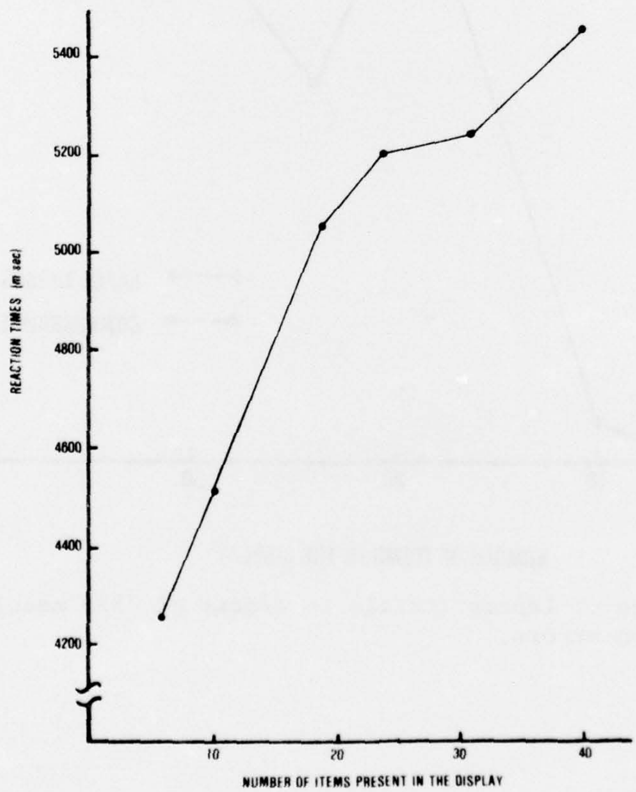

Figure 3. Mean display search reaction times as a function of the number of displayed items.

[2] Conservative degrees of freedom were used in arriving at significance probabilities of repeated measures effects in all ANOVAs.

Two other measures were available for the display search in addition to reaction time. The first, which is called a lapse, reflects all times in excess of 7999 msec. The second is an error of commission, or entry error, in which the operator depresses the wrong key during entry of the three-digit number corresponding to the target item. Figure 4 displays the percentage of both these measures as a function of display size. As shown, the lapse measure shows the influence of display size while entry errors do not. The lapse measure finding is not unexpected as it reflects the excessively long reaction times. The entry error appears to be determined by processes that are more or less independent of the search process.

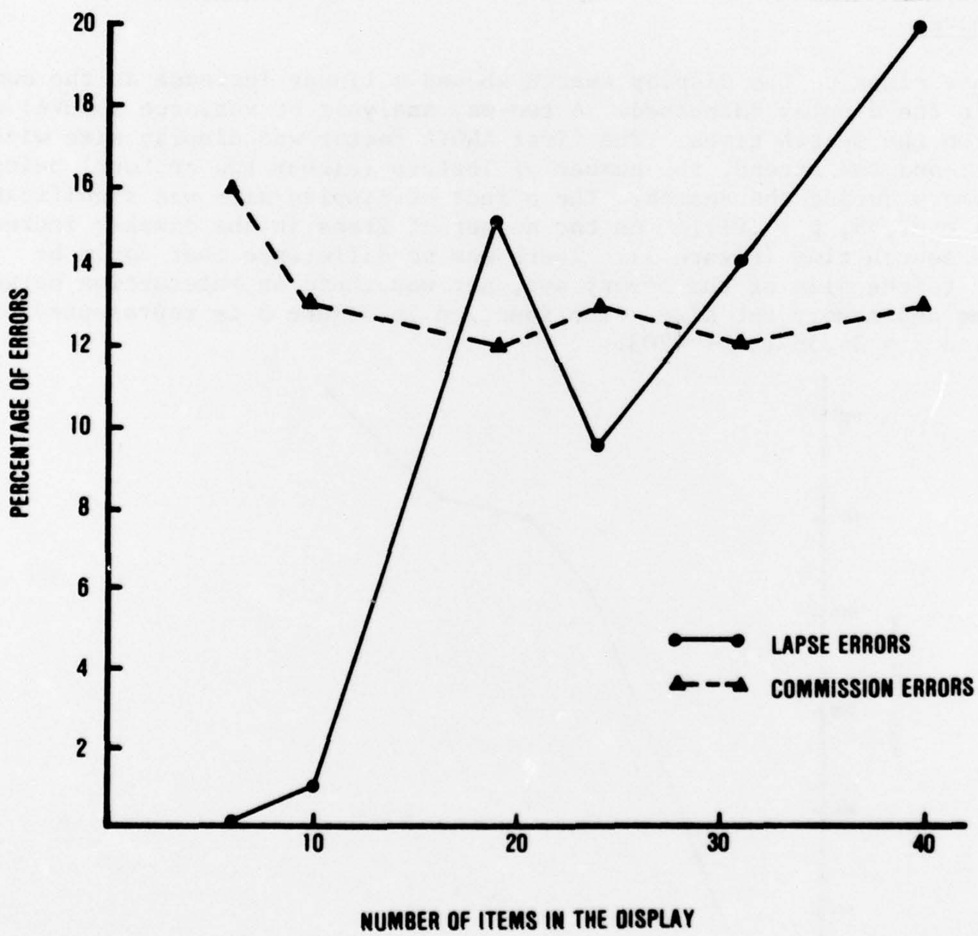

Figure 4. Percentage of lapses (trials in excess of 7999 msec) and commission errors.

Relative Target Item Location

The six separate display formats (Figure 2) were divided (by eye) into four quadrants and examined for possible location effects. For example, participants may prefer to scan an array from top to bottom or from left to right in search of the target. Figure 5, which provides mean reaction times and lapse percentages for each quadrant, shows that there is no significant difference among the four quadrants. The task was not specifically designed to examine relative location, because the information was not uniformly distributed among the quadrants. Format irregularities such as item density may also play a role in search scan strategies.

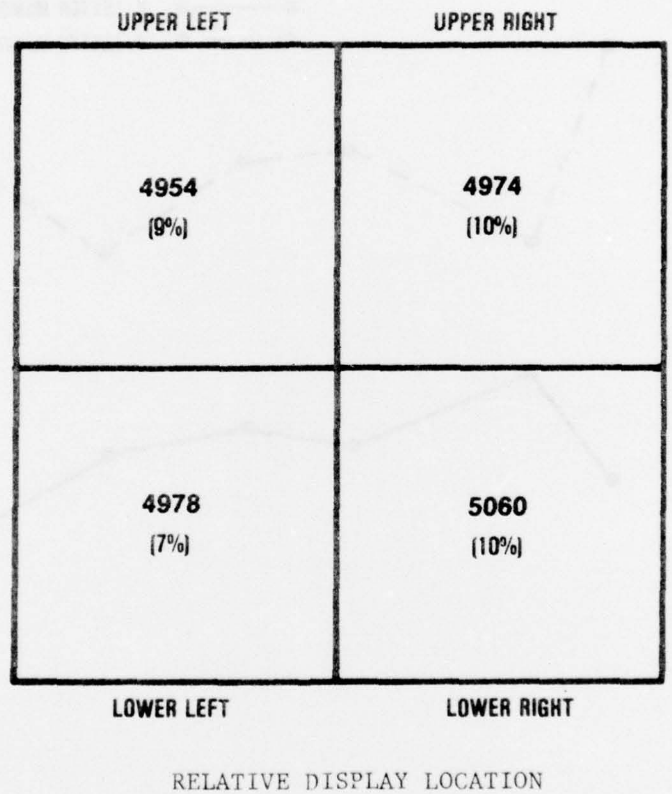

Figure 5. Mean display search reaction times (msec) and lapse percentages for each quarter of the screen.

Transition Effects

Transition effects describe changes in performance over time and may reflect improvement (practice effect) or decrement (fatigue). In this experiment, a crude examination of transition was made by dividing the 120 trials for each operator into two blocks, representing the first and second halves of the trials. The mean reaction times for the first and second blocks, across all display sizes, were 4969 and 4886 msec respectively. Neither this difference nor the difference between lapse percentages in the first and second blocks of trials was significant.

Memory Task

Reaction times were recorded to the single letter probe to which the operator responded Yes or No. A two-way ANOVA was performed with display size (six levels) and memory set size (two or four letters) as factors. Results showed that there was a significant main effect of memory set size, $F\ (1, 17) = 25.87$, $p < .01$.[3] The mean reaction times for the two- and four-letter trials were 1183 and 1329 msec respectively. There was no effect of display size on the memory probe, and there was no interaction. Figure 6 shows the mean RT for both memory sets and each display size.

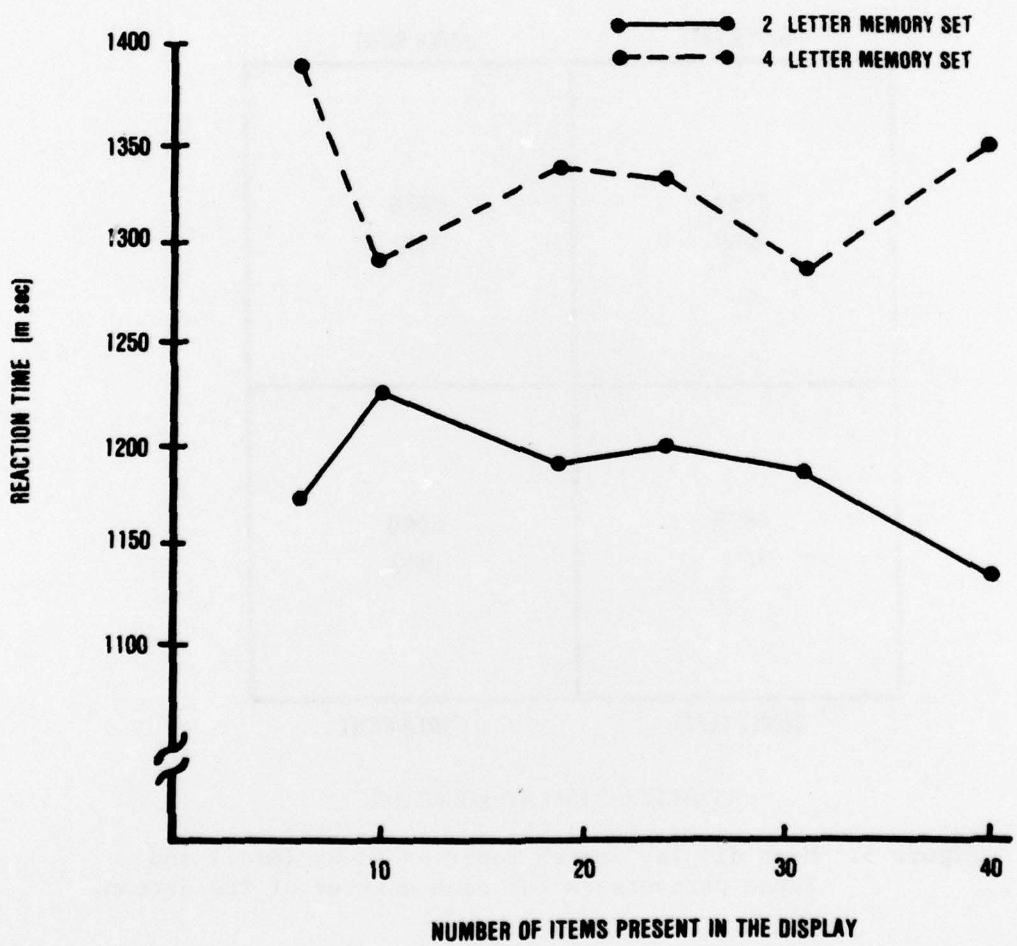

Figure 6. Reaction times to memory probe for two- and four-letter memory sets as a function of display size.

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[3] See footnote 2.

Correct positive responses to the memory set probes were faster than correct negative responses; however, these differences were not significant. Figure 7 displays reaction times to both memory set sizes and to positive and negative probes, collapsed across all six intervening displays.

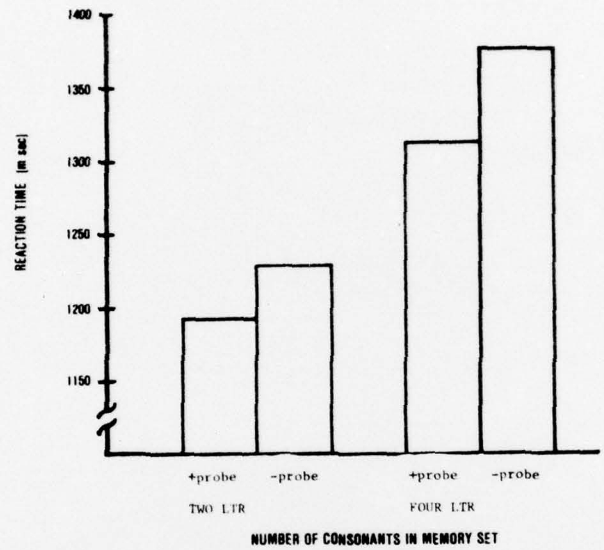

Figure 7. Reaction time to memory probe as a function of number of consonants in memory task.

CONCLUSIONS AND RECOMMENDATIONS

The most important consideration of display design on search performance in this task is the total number of items through which the operator must search. The extent to which formatting can influence the search performance cannot be determined within the range of formats used in this study. Because of the necessary limitations on format imposed by the NTDS system and the variety and complexity of console operator demands, it may not be feasible to impose more radical formatting standards. In this case, the most straightforward approach is to format according to logical, conceptual guidelines currently in existence and to limit the number of items displayed to that which can be scanned in about 1 second. This time period is based only on the slope shown in Figure 3 and encompasses up to about 30 items. At 35 msec per item, the search time would be 1050 msec. An assumption in this recommendation is that the intercept (4200 msec) represents overhead time for preparing to search and entering the numbers on the keyboard after locating the target. This assumption is widely adopted and follows from the work of Sternberg (1969). Studies which examine the nature of overhead time, attributable to keyboard entry, are currently underway at NAVPERSRANDCEN.

Nevertheless, we recommend that some alterations in format be examined in continued research. For example, NTDS conceptual categories may be segregated on the screen by the use of space or boundaries. Such division may be based on own ship, target, and weapon considerations. Another approach is to examine the trade-off between size of display and type of response. For example, when more than one information item must be located to perform the response, an effectively formatted large display might be more advantageous than multiple-display call-up. Research directed toward these questions also is currently underway at NAVPERSRANDCEN.

The short-term memory load imposed in this experiment was not sufficient to influence search time, which supports the findings of Wallenbarger and Pachella (1972). Since it is doubtful that the results would be significantly different with no memory load, further studies should either omit the interpolated memory task or use a larger set to impose a greater demand.

It is recommended that scanning patterns be examined more closely, particularly as a function of different formats. Although the results in this study were negative, a controlled examination of scan strategy on NTDS formats is warranted. There is a suggestion of upper left to right scan in the reactions shown in Figure 5.

Practice effects, although pervasive in most reaction time studies, were not evident. Operators did not show either improvement or fatigue over the 1-hour period. Since NTDS operators are highly experienced, it is recommended that an experienced group of operators be tested in a similar task in order to confirm or disconfirm the results. With many trials, effective display size should be reduced. This is not to say that results using inexperienced operators are invalid. In fact, the display tested here should be useful to observers who might not be completely familiar with NTDS console operation.

REFERENCES

Atkinson, R. C., Holmgren, J. E., & Juola, J. F. Processing time as influenced by the number of items in a visual display. Perception and Psychophysics, 1969, 6, 321-326.

Egeth, H., Atkinson, J., Gilmore, G., & Marcus, N. Factors affecting processing mode in visual search. Perception and Psychophysics, 1973, 13(3), 394-402.

Egeth, H., Jonides, J., & Wall, S. Parallel processing of multielement displays. Cognitive Psychology, 1972, 3, 674-697.

Gardner, G. T. Evidence for independent parallel channels in tachistoscopic perception. Cognitive Psychology, 1973, 4, 130-155.

Kelly, R. T. Modality-specific interference in dual task performance. Unpublished Ph.D. dissertation, New Mexico State University, 1976.

Monk, T. H. Target uncertainty in applied visual search. Human Factors, 1976, 18(6), 607-612.

Sternberg, S. Mental processes revealed by reaction time experiments. American Scientist, 1969, 57, 421-457.

Teichner, W. H., & Mocharnuk, J. B. Predicting human performance VII: Visual search for complex targets (Tech. Rep. 74-2). New Mexico State University, April 1974.

Wattenbarger, B. L., & Pachella, R. G. The effect of memory load on reaction time in character classification. Perception and Psychophysics, 1972, 12(1B), 100-102.

REFERENCE NOTES

Copies of the following studies are available from the Fleet Combat Direction Systems Support Activity (FCDSSA) Library, San Diego, California 92147.

1. A comparative analysis of data presentations to the OJ-194 console CRT and DRO. Fleet Computer Programming Center, Atlantic 72-53 (IR(A)-2060).

2. Naval tactical data system memorandum report PPI data display study (MR-J71-074). Prepared by Computer Sciences Corporation.

3. Information display formats for NTDS consoles with alphanumeric CRT readouts (CRO), IR-2365.

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Chief of Naval Material (NMAT 08T244)
Chief of Naval Research (Code 450) (4)
Chief of Naval Education and Training (N-5)
Chief of Naval Technical Training (Code 016)
Chief of Naval Education and Training Support
Chief of Naval Education and Training Support (01A)
Chief of Information (OI-2252)
Director of Navy Laboratories
Commander Training Command, U. S. Atlantic Fleet (Code N3A)
Commanding Officer, Fleet Combat Direction Systems Support Activity, San Diego (Code 27) (15)
Commanding Officer, Naval Training Equipment Center
Commanding Officer, Fleet Combat Training Center, Pacific (Code 00E)
Commanding Officer, Naval Education and Training Program Development Center
Commanding Officer, Naval Development and Training Center (Code 0120)
Commanding Officer, Naval Aerospace Medical Institute (Library Code 12) (2)
Commanding Officer, U. S. Naval Station, San Diego
Director, Training Analysis and Evaluation Group (TAEG)
Army Research Institute for the Behavioral and Social Sciences
Personnel Research Division, Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base
Occupational and Manpower Research Division, Air Force Human Resources Laboratory (AFSC), Brooks Air Force Base
Technical Library, Air Force Human Resources Laboratory (AFSC), Lackland Air Force Base
Technical Training Division, Air Force Human Resources Laboratory, Lowry Air Force Base
Flying Training Division, Air Force Human Resources Laboratory, Williams Air Force Base
Advanced Systems Division, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base
Program Manager, Life Sciences Directorate, Air Force Office of Scientific Research (AFSC)
Army Research Institute for the Behavioral and Social Sciences
Coast Guard Headquarters (G-P-1/62)
Director of Acquisition Planning, OASD, (I&L)
Military Assistant for Training and Personnel Technology, ODDR&E, OAD (E&LS)
Defense Documentation Center (12)